

Spectrum Efficiency: Making the most of the available mobile spectrum

John Burns
Aegis Systems Ltd

*Presentation to joint DCKTN / Cambridge Wireless event
“Spectrum and the New Economy”
24th September 2009*

Main Points

- What is spectrum efficiency and why is it increasingly important?
- Using spectrum to optimise network capacity and coverage
- Why a multi-band approach is best
- How technology evolution and market consolidation can help
- Conclusions and a possible action plan

What is Spectrum Efficiency?

Technical Efficiency

- Quantitative: Bits per Hz (per sq km)
- For mobile, need to consider **average throughput** not just peak rate
- Qualitative: using available spectrum in the best way to achieve **coverage** and **capacity** objectives

Economic Efficiency

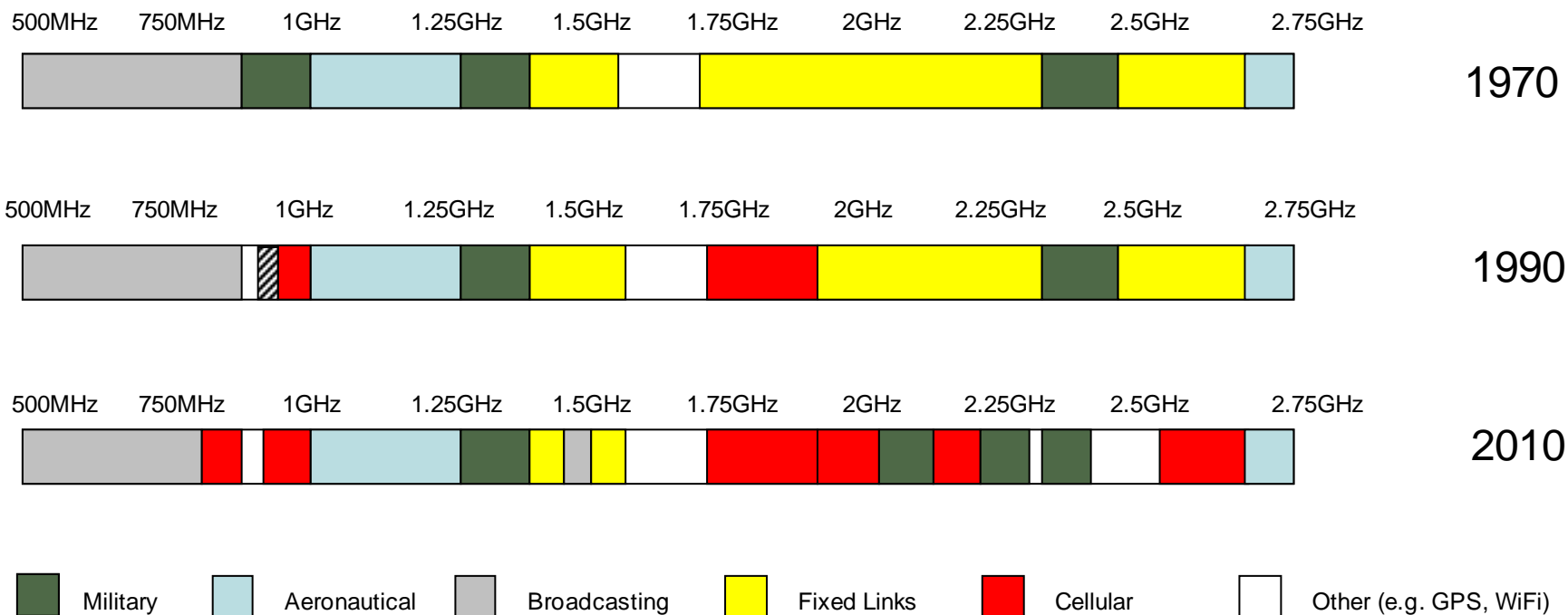
- Maximising **economic and social benefit** per MHz
- Apportioning spectrum to promote **effective competition** (implies more networks) whilst **avoiding excessive costs** (through network duplication)
- For the operator, ensuring adequate **return on investment** in spectrum

Why is it so important?

- **Wireless is a key element of Digital Britain**
- 3 objectives defined for wireless infrastructure:
 - Rapid Transition to High Speed Mobile Broadband
 - Progress towards Universal Coverage in 3G and Next Generation Mobile, including reliable coverage on rail network
 - Maintaining a highly competitive market
- Need to consider how best to achieve this with the limited spectrum resources available

There is limited scope for more mobile spectrum

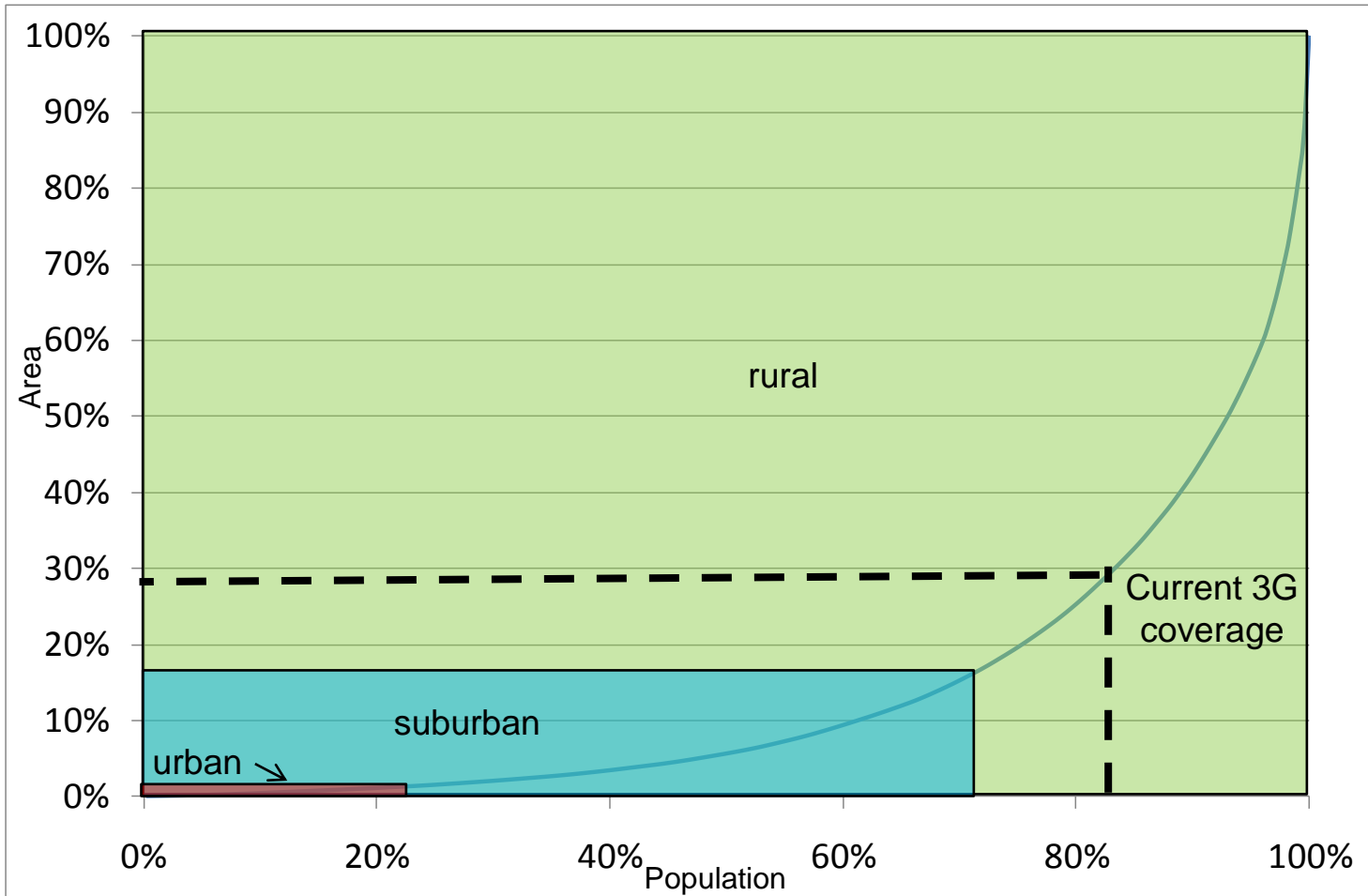
- Historically, cellular expansion was facilitated by migration of other (mainly fixed) radio allocations to higher bands
- Little scope for further migration so have to have to make best use of what we already have



Meeting the Coverage Challenge

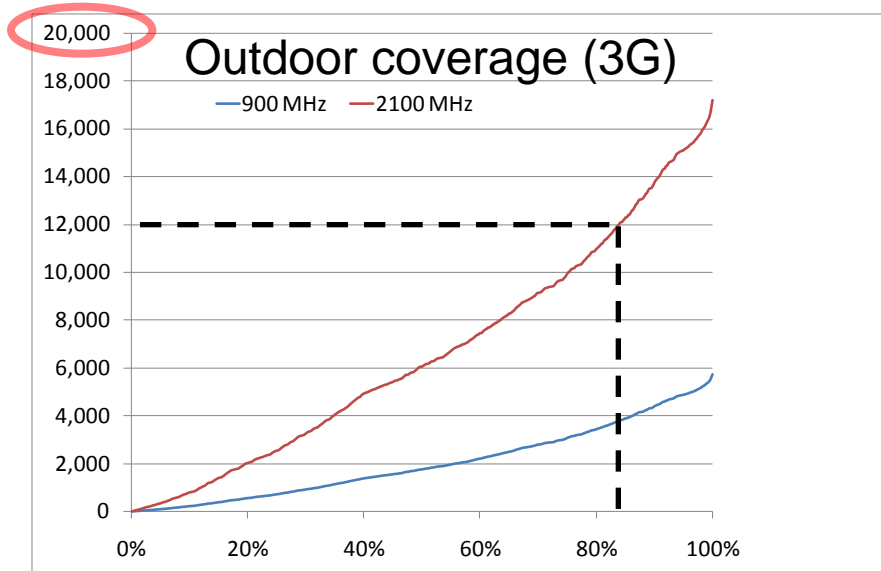
- 2G (GSM) coverage almost universal (>99% population) but numerous “not-spots” still exist
- 3G coverage about 80 – 90 % depending on network
- Quality of 3G coverage very variable (especially indoors and in vehicles)
- Coverage ultimately depends on two factors, namely
 - Number of base stations
 - Frequency band deployed

UK Population Distribution

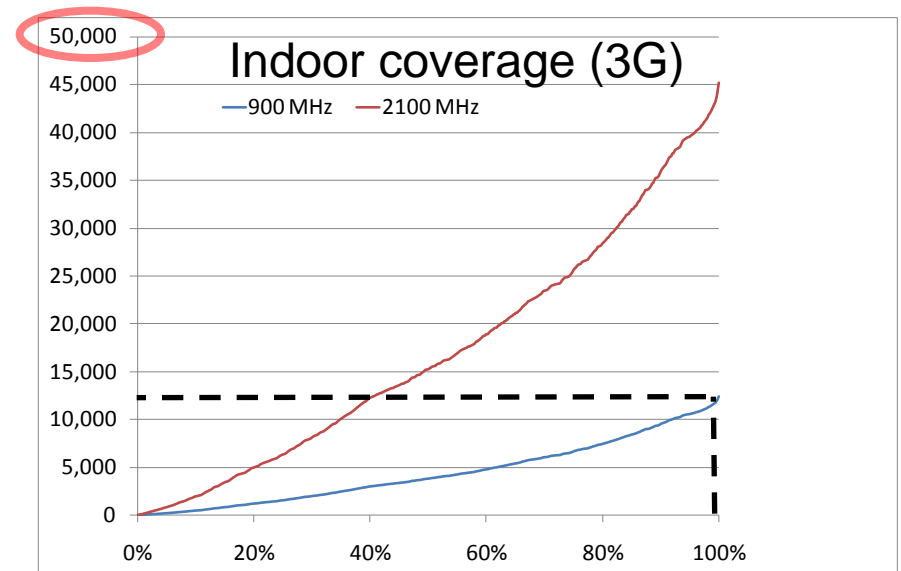


What does this mean for network infrastructure costs?

- Required sites depends on frequency band (lower frequencies go further) and quality of coverage:



*Where we are now
~12,000 sites, ~85% pop*



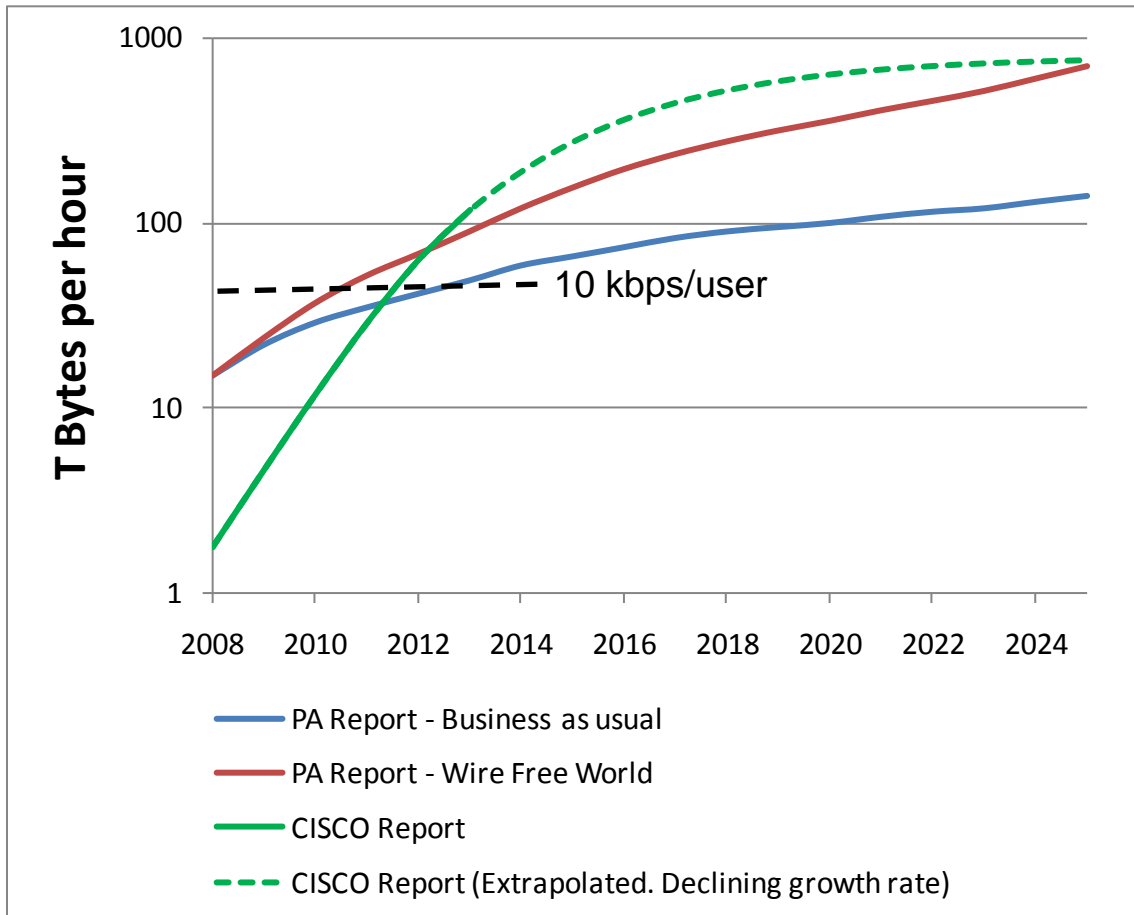
*Where we would like to get to
~12,000 sites, ~100% pop*

But what about capacity?

- Need enough cells and frequencies to cater for required traffic
- Current technology (HSPA) delivers about 1.5 Mbps per 5 MHz carrier (average throughput)
 - = *9 Mbps per site for operator with 2x10 MHz*
 - *Assume 10 million users averaging 10 kbps (busy hour)*
 - = *100 Gbps total across network*
 - (100,000/9) = **11,000 sites** if traffic evenly spread across network*

So OK for now, but what about the future?

UK Traffic Growth Forecasts



Sources:

“Predicting Areas of Spectrum Shortage”, Final report for Ofcom Prepared by PA Consulting, April 2009

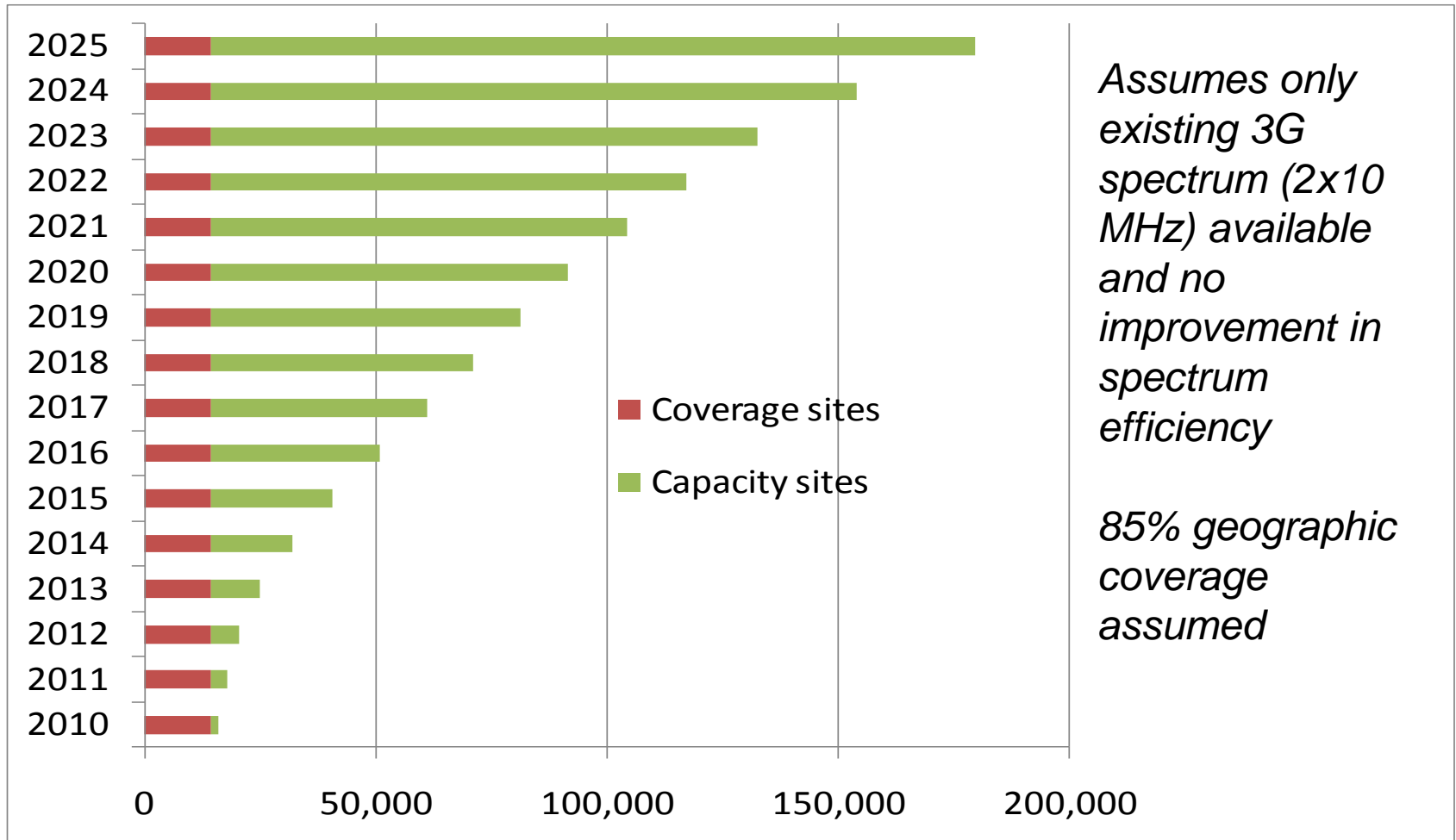
Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, January 29, 2009 (scaled pro-rata by population from Western European estimates)

(10 kbps / user = 45 TBytes/hour assuming 10 million users)

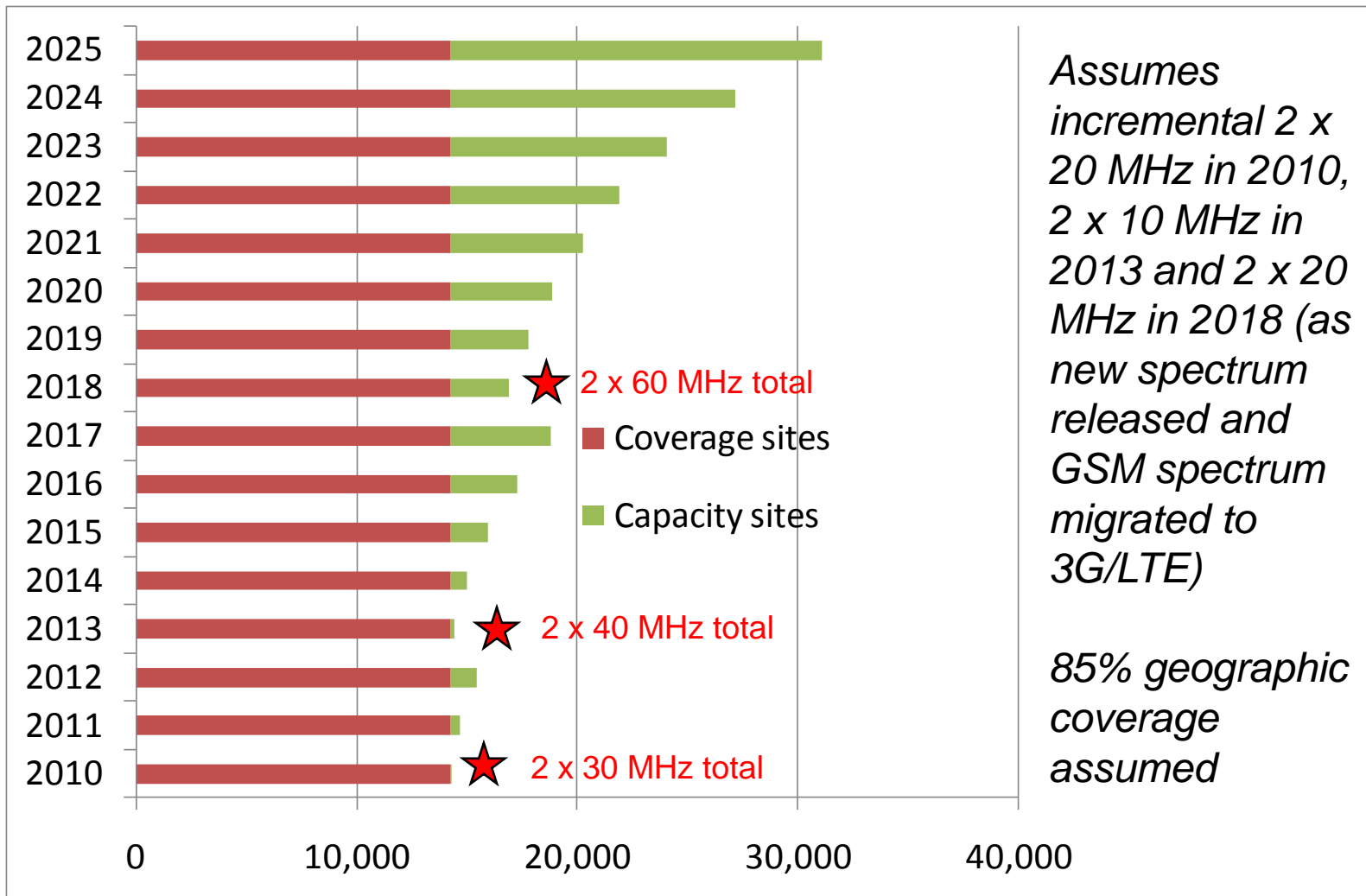
3 ways to deliver this growth:

1. Deploy more cell sites
 2. Acquire more spectrum
 3. Use more efficient technology
- In practice, will probably need to use all three!

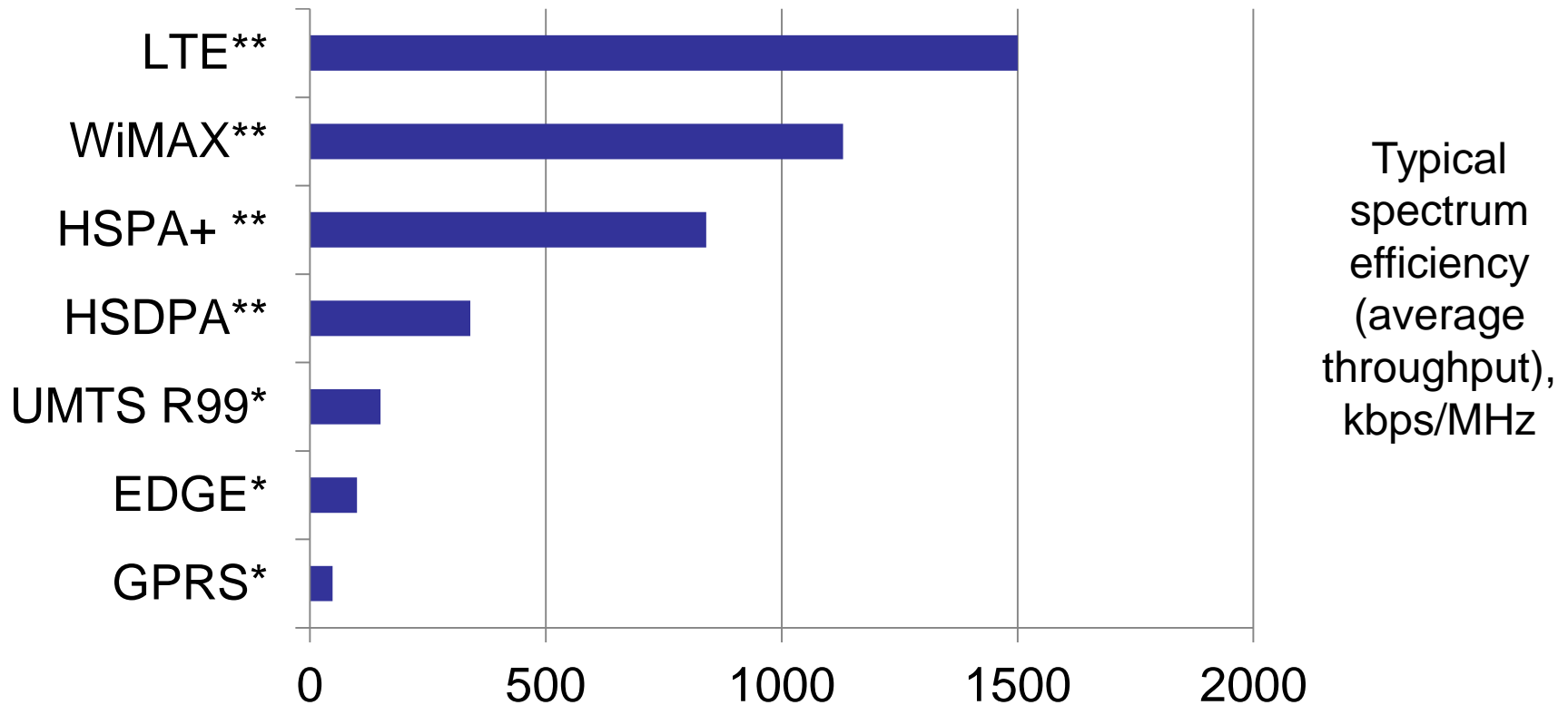
New sites alone not a viable option



More spectrum helps—up to a point

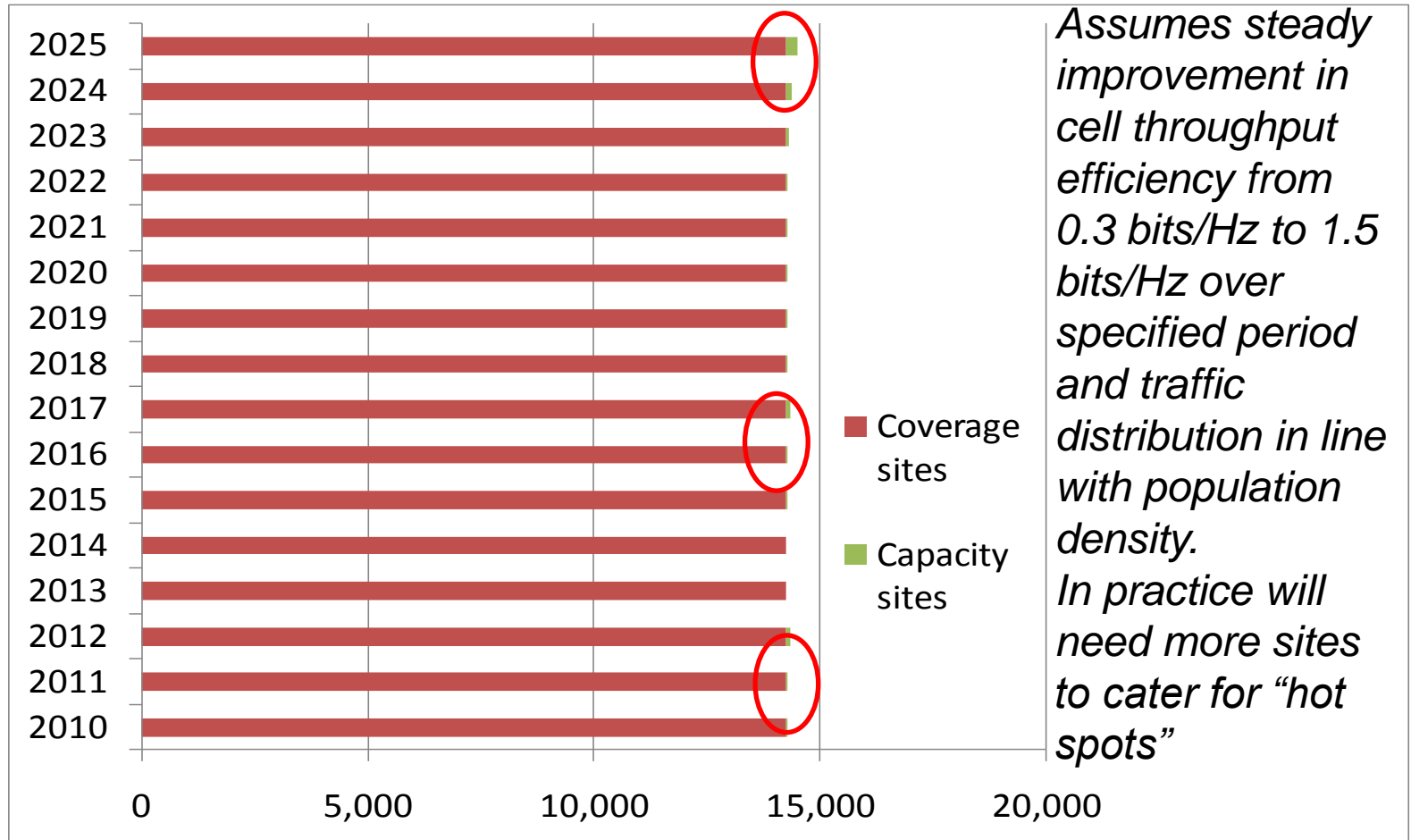


But technology evolution could have a greater impact...



Data sources: *Qualcomm, **Vodafone

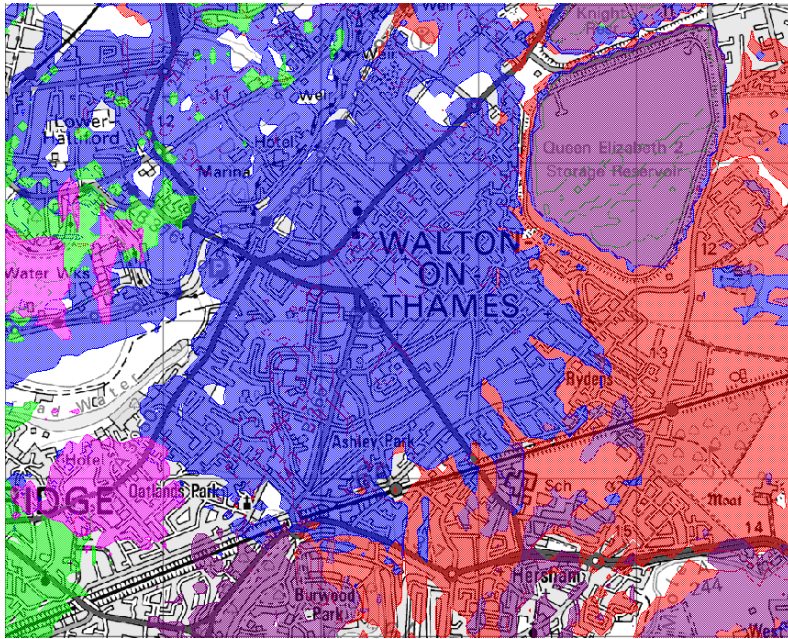
Impact of technology evolution



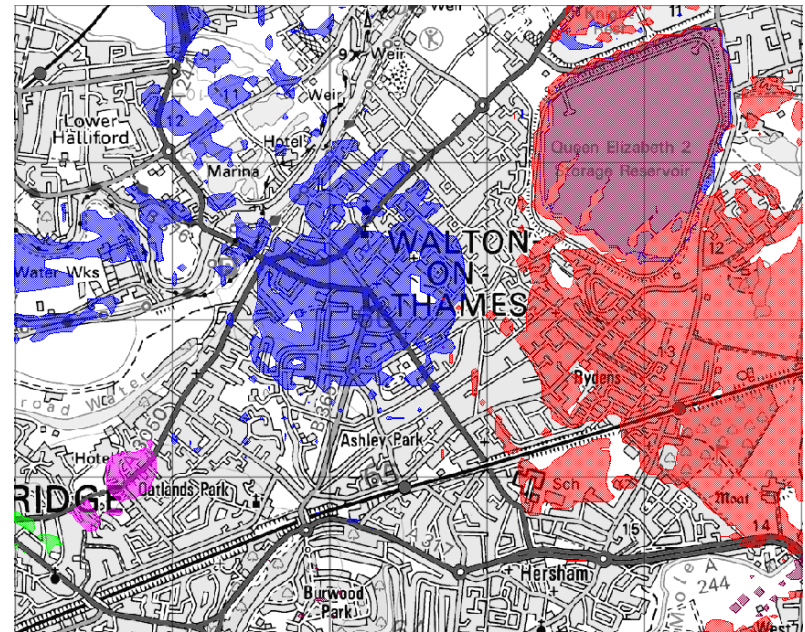
What about quality of coverage?

- Today's coverage is good outdoors but patchy indoors
- Ideally need good coverage in buildings, on trains etc
- Could build more sites or rely on pico / femto cells
 - but expensive and time consuming
- Or improve coverage of existing sites
 - by deploying lower frequencies

Indoor and outdoor 3G coverage (2 GHz)



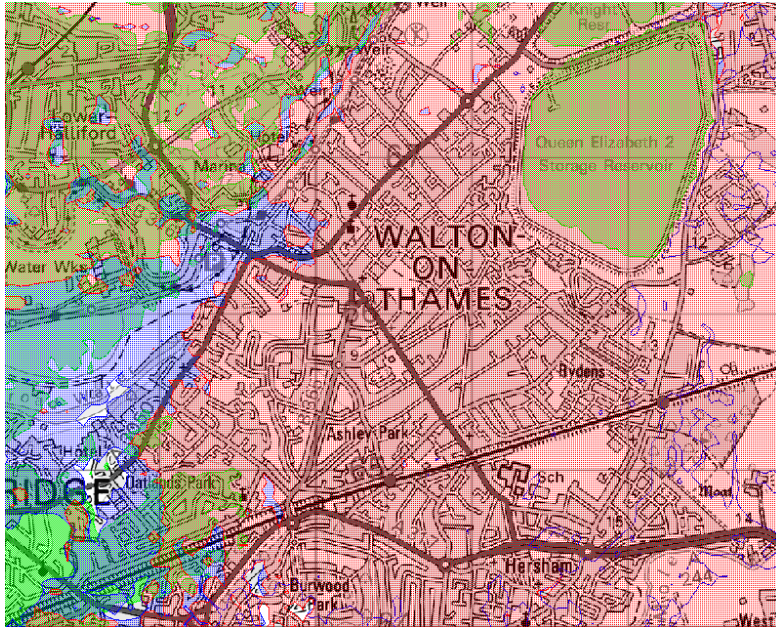
Outdoor coverage (58 dBµV/m)



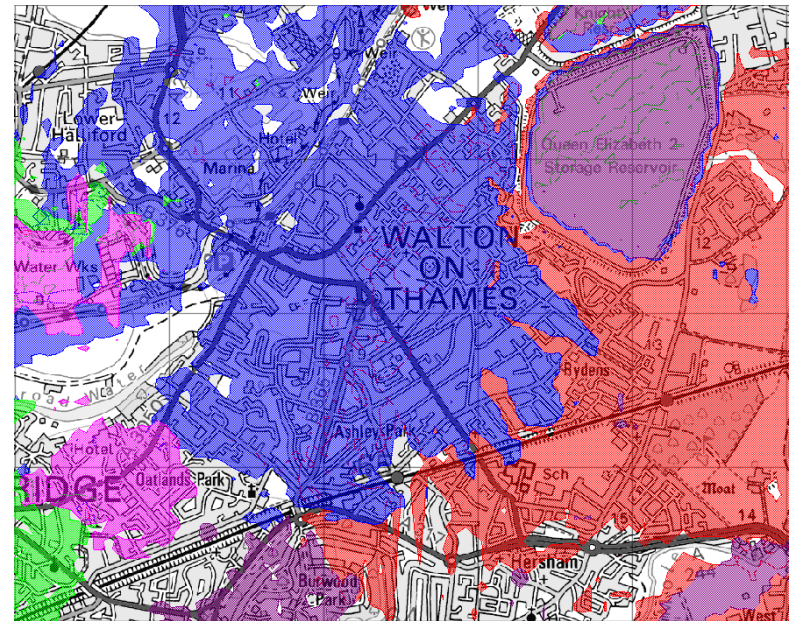
Indoor coverage (72 dBµV/m)

Site parameters based on Ofcom Sitefinder data for a single 3G network

Impact of 900 MHz



Outdoor coverage (51 dBµV/m)



Indoor coverage (63 dBµV/m)

Site parameters based on Ofcom Sitefinder data for a single 3G network

- **Note indoor coverage now similar to existing (2 GHz) outdoor coverage**

Benefit of dual frequency bands

- Much cheaper to extend coverage to areas currently unserved with spectrum < 1 GHz
- In existing coverage areas can use lower frequencies to enhance indoor coverage and higher frequencies for outdoors
- Retain fast moving users on lower frequencies to reduce handover overheads
- But not all UK operators currently have this flexibility

Balancing competition and costs

- Too few networks = limited competition
 - Higher prices and poorer service
- Too many networks = excessive network costs
 - Higher prices and poorer service
- Market consolidation around the world suggests optimum number is 3 – 4
 - Also leads to more balanced spectrum holdings
 - Competition can be maintained via MVNOs
- Networks can also cut costs by co-operating
 - e.g. Three / T-Mobile joint venture

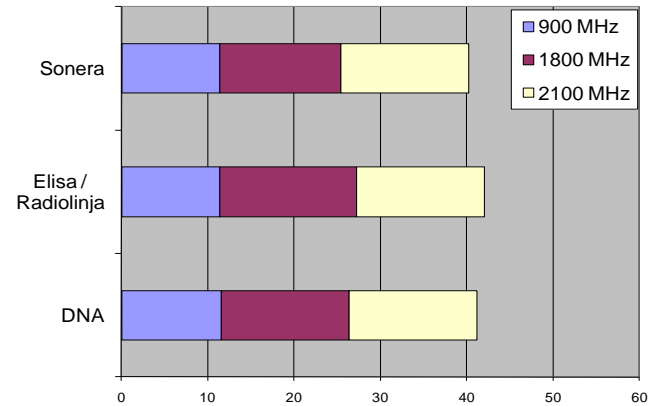
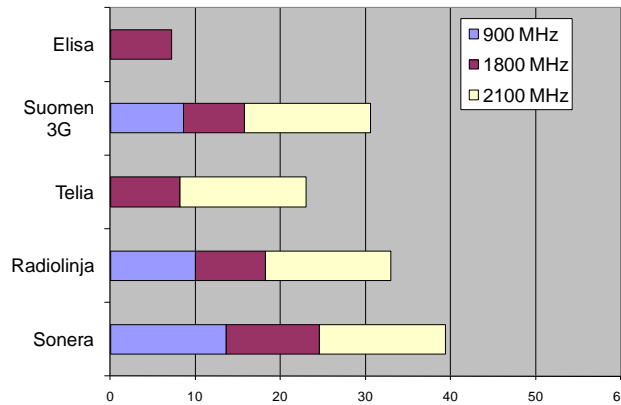
Market Consolidation in Europe

2001

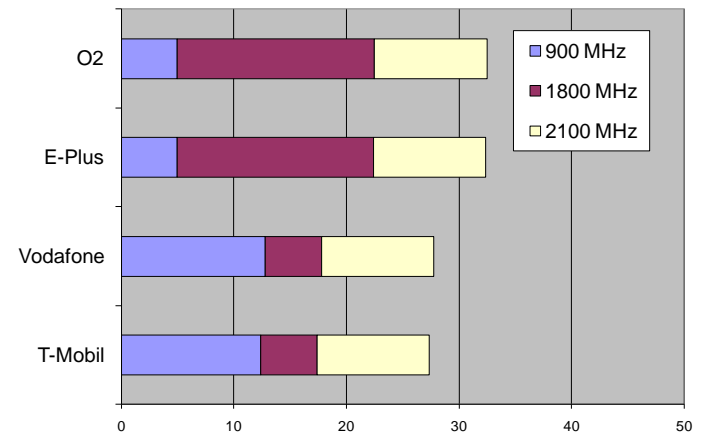
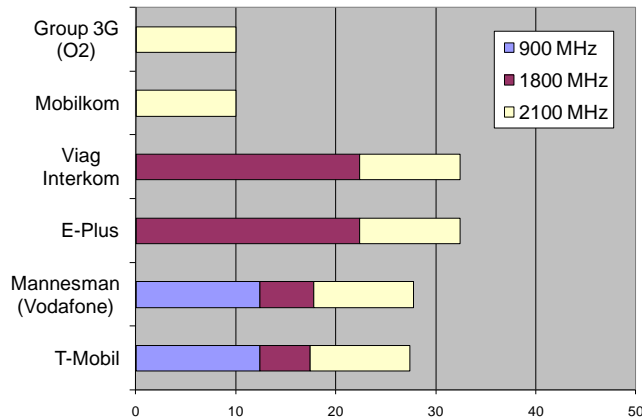


2009

FINLAND



GERMANY



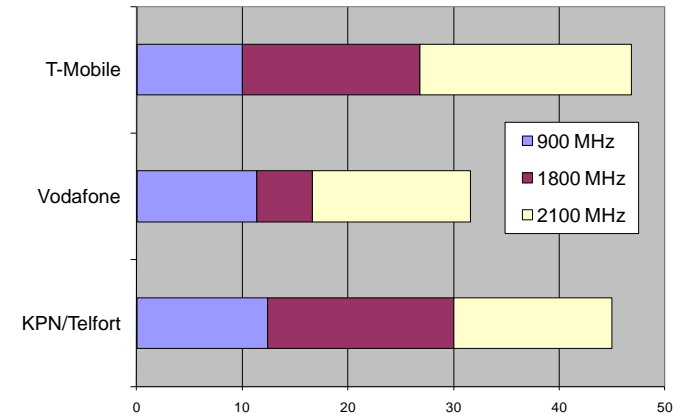
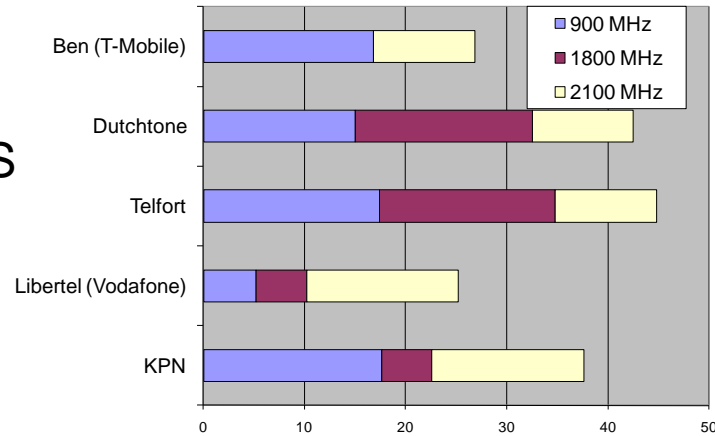
Market Consolidation in Europe

2001

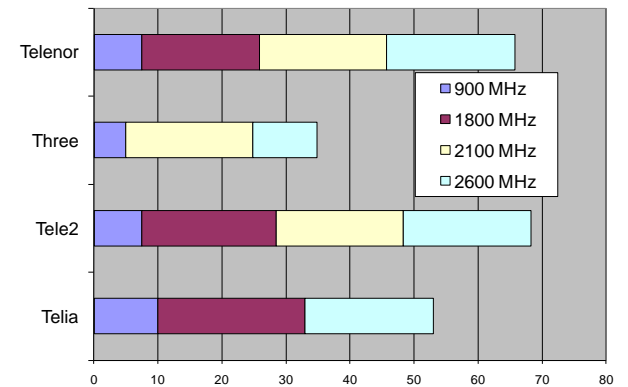
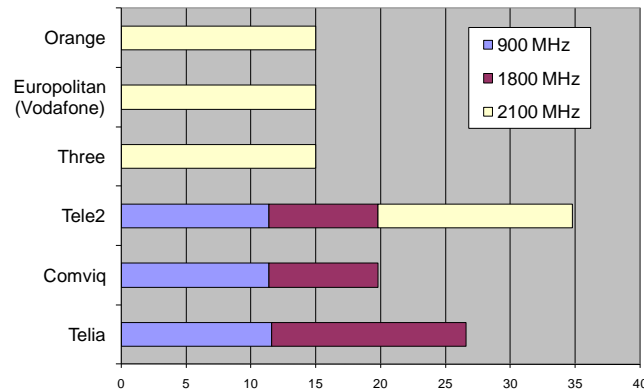


2009

NETHERLANDS

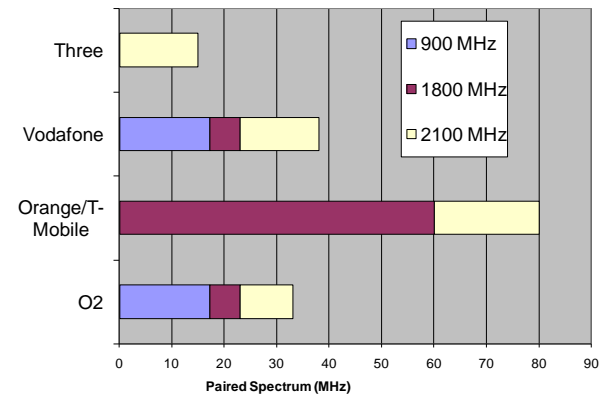
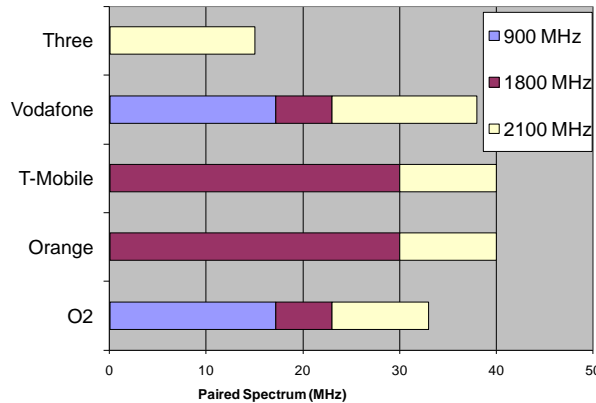


SWEDEN



Market Consolidation in the UK...?

T-Mobile / Orange Merger



- Makes sense in terms of balancing competition and costs
- But doesn't help in terms of promoting better coverage
- Imbalance of 1800 MHz holdings – could be merit in swapping some of this for 900 MHz, or maybe to provide cost-effective backhaul in remote areas?
- Interesting situation with regard to Three – Network sharing arrangement with T-Mobile and National Roaming Agreement with Orange.
- Suggests scope for further consolidation (but still wouldn't help with coverage!)

Conclusions

- Mobile Spectrum is in limited supply and efficiency improvements will be essential to meet capacity growth and deliver required breadth and depth of coverage
- Improving technology means existing allocated spectrum (including new bands) should provide sufficient capacity for foreseeable future
- Coverage – extending geographic availability and improving quality in existing areas – is a bigger challenge requiring access to an appropriate spectrum mix
- The “digital dividend” will help but not until after 2012
- In the meantime action is required to ensure equitable access to 900 MHz spectrum

A possible action plan?

- Independent Spectrum broker's plan based on access to 800 MHz (digital dividend) – but not until 2012
- Need action now on 900 MHz to achieve objectives of Digital Britain
- May involve re-apportioning some of Vodafone / O2's spectrum
 - Could offer more 1800 MHz in return
 - Single 2x5 MHz block may be sufficient if T-Mobile / Orange merger goes ahead and existing arrangements with Three extend to 900 MHz
- Alternatively could apply roaming or MVNO conditions to existing 900 MHz spectrum as condition of refarming to 3G, pending availability of 800 MHz

Thank You!

- For further information please contact:

John Burns
Aegis Systems Ltd
Tel +44 1932 860074
john.burns@aegis-systems.co.uk